Functional Requirements for Microcomputers for Educational Use in Ontario Schools

Stage 1A

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FUNCTIONAL REQUIREMENTS FOR MICROCOMPUTERS FOR EDUCATIONAL USE IN ONTARIO SCHOOLS - STAGE IA

1 Assumptions

In issuing this set of refined functional requirements a number of assumptions have been made by the Ministry of Education.

1.1 These specifications are for a family of microcomputers for use in schools in Ontario which will continue to evolve in tandem with developments both in learning theories and computer/communications technologies in their broadest respective senses. The criterion for inclusion of any specification is educational. The family must provide for a rich set of possible uses in providing those services. A rational, consistent and straight forward user interface is essential.

1.2 These requirements, by setting a public standard for educational computers in Ontario, will have a significant steering effect on the development of computer use in education. The experiences today's student have with information technology will shape their understanding and capabilities for using such technology as adults. Equipment specified herein must be designed to perform current applications but anticipate the type of information technology environment today's students are likely to find in their adult life. Information manipulation in the educational environment has a different emphasis from that of the business and scientific environment. A rich set of information representation and tools for its manipulation are necessary in the educational context.

1.3 The rate of introduction of microcomputers in the Ontario educational system will depend to a great extent on the availability of quality educational software (lessonware and courseware: generative and expressive).

1.4 With only limited numbers of microcomputers available, most current applications are in the standalone mode. It is assumed, however, that classroom and school networks will grow to enable students and teachers to maximize the sharing of resources and the use of sophisticated tools to facilitate maximum learning by students.

1.5 The student-teacher relationship in the classroom must be enhanced by the family of microcomputers e.g. - teacher must be able to give simple directions for accessing a wide variety of learning material and lessonware consistent with the needs of the student and be able to collate information about the successes and failures of students using these materials.

1.6 The Ministry continues to emphasize an earlier statement of purpose: "The more significant way (to use computers in the process of teaching and learning) will be the creative use of the computer by individuals: writing, composing, designing, analyzing, and other extensions of original thought. All students must be given opportunities to use computers in this way." It is essential the total configuration place the greatest possible amount of computing power in the student microcomputer to facilitate this individual creative use.

1.7 Current evidence shows that all students can use microcomputers to facilitate learning. The use of colour, sound, graphics and animation can be incorporated to aid learning for all children.

2 Uses In Schools

The family of microcomputers must fulfill the following uses in a variety of school environments.

2.1 Interest Centre in an Elementary Classroom

In this setting the microcomputers become an interest centre which students use for a variety of applications: diagnose and review learnings, develop concepts, use LOGO, simulate experiments, processes or events, learn new concepts, use language processors to write stories, play an educational game and learn programming skills. These applications require two or three microcomputers with access to a broad range of lessonware and applications software. A printer is needed.

2.2 The Computer Integrated into the Classroom

In this setting the teacher integrates the computer into the learning activities for the introduction and development of concepts and skills with words, numbers, shapes, colours and sounds. The teacher makes extensive use of sound generation, colour graphics and animation to enable students to simulate experiments, processes or events, analyze data, plots graphs, develop models and process information. Four to eight basic microcomputers are integrated into such an environment with an advanced microcomputer which enables the teacher to monitor the progress of the pupils. Extensive storage, files management capability and a printer which is capable of graphics output are necessary.

2.3 The Computer as an Instructional Tool for the Teacher

The teacher uses a microcomputer to simulate experiments, organize and manipulate information for the entire class, develop data bases of relevant course material and possibly interface the machine to video disc or video tape players. Teachers need high quality graphics to properly simulate experiments and processes. Teachers will access external data bases to bring relevant information into the classroom.

2.4 Intermediate Division Computer Classroom

To meet the diverse needs and interests of students and teachers some elementary schools find it useful at the present time to consolidate all of the computers into one room under the direction of a knowledgeable teacher. In this environment classes of students are scheduled into the classroom for a set period of time each week. Applications include computer literacy, programming skills, language processing, lessonware, courseware, educational games, stimulations and concept exploration. It is anticipated these functions will quickly migrate to the individual classroom as teachers integrate such applications into their day to day classroom activities. This will require a network of 12 to 18 basic machines (one for every two students) with extensive storage, file organization capability and a printer.

2.5 Teaching of Word Processing in Secondary Schools

It is now becoming desireable to replace traditional classrooms of typewriters with full class sets of microcomputers for the development of keyboarding skills. In addition a network of microcomputer/fileserver and 6 or 8 basic machines are required in a small classroom or as part of a traditional office practices room. Students need their own workspace, personal electronic storage and access to a letter quality printer.

2.6 Teaching of Computer Science and/or Business Applications in a Lab Environment

This requires a network of a central microcomputer/fileserver and 12 to 16 (one machine for every two students) or ultimately 24 to 32 (one per student). It has been shown that students can work successfully in pairs for courses which require considerable student planning and paper preparation. Each student needs his/her own personal electronic workspace and storage area as well as access to a rapid printer.

2.7 Using the Microcomputer in the Resource Centre

The resource centre should have equipment available to students at all times. A variety of lessonware/courseware is required for the preparation of assignments, to gain access to course materials which they may have missed in class or to improve a skill level. In addition it is in this setting that the equipment is used to access a wide variety of data bases to gather and analyze information for assignments. This requires several basic machines for the lessonware/courseware as well as one or two advanced machines with communications capability. A printer is required in this environment.

2.8 School Administration

Some schools are building a computer network to facilitate the administration of the schools: attendance, student files, mark collection, timetable, messaging etc. This requires access to large storage, several printers of differing quality and communications access to the board level computer system.

3 General Requirements

3.1 These functional requirements for computers eligible for funding by the Ministry of Education describe a family of compatible microcomputers, fileservers and operating software which will have a 10 year functional life, provide for the portability of educational software and facilitate the integration of new technological developments. The family must contain components which can optionally function in a stand alone mode, as part of a classroom local network to share peripherals (various forms of storage and printers) and as part of a school based network to facilitate access to external resources and the central sharing of lessonware, courseware, data bases and administration information. The family must be capable of interconnection in a variety of configurations as student needs and course requirements evolve overtime (e.g. CAD/CAM and design courses).

3.2 Ontario licensed educational software will only be available under a common software portability environment based on the Educational Application Software Interface (EASI ... defined in a document to be released by the ministry in Fall 1988). Any new ministry sponsored software development will be based on this environment. Schools will be notified that ministry licensed software will be available only within this environment. Vendors must commit to the adoption and implementation of this EASI. The full cost of implementing the EASI on a vendor's Stage I or Stage IA system(s) is to be borne by the

vendor. All qualified vendors must cooperate fully with the ministry in the initial development, verification and evolution of this software portability environment and must commit to implementing fully conforming systems within timelines published by the ministry.

3.3 These functional requirements represent a basic definition of products and a direction, but are not exhaustive in that certain details necessary to the reasonably effective and efficient uses of the product(s) for educational purposes, may have been either omitted or included without sufficient detail.

It is therefore a general overriding specification, included in lieu of such missing or insufficiently detailed elements, that:

- the products specified be representative of state-of-the-art microcomputer implementations and performance; (16 and /or 32 bit processor chips);
- the products specified be easy to use by teachers and students;
- the software speed of execution be high and the response time to commands be low in comparison with state-of-the-art microcomputer implementations;
- the products be easy to install;
- the quality of all documentation be high;
- the identification of the source of most malfunctions (hardware or software) be possible by an untrained user.

4 Safety and Ergonomic Factors

4.1 Each machine must carry CSA approval or Ontario Hydro approval on an interim basis.

4.2 All VDT'S must meet the Federal Safety Code and the recommendations of the Ontario Ministry of Labour in connection with any form of radiation.

4.3 Character and symbol representations must be clear and easily distinguishable with a recommended minimum of 10 vertical pixels x 7 horizontal pixels per character and with true descenders. Regardless of actual character cell resolution, all characters including both upper and lower case accented French characters, must be clearly displayed.

4.4 Display surfaces must have an anti-glare finish and all images must be clearly visible in brightly lit rooms and be flicker-free.

4.5 All VDTs must be tiltable to facilitate use by varying sizes of children.

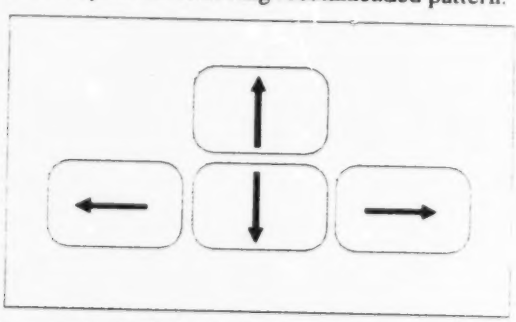
4.6 All members of the family must be designed to inhibit unauthorized access to the internal components.

5 Keyboards

5.1 All members of the family must provide a bilingual English and French keyboard (upper and lower case) and support alternate language keyboards and special adaptations for the handicapped. Appendix 2 indicates the basic key layout for all bilingual keyboards. In addition, all French language accented characters (both upper and lower case) must be capable of being generated using no more than two keys in the case of lower case characters and no more than three keys in the case of upper case characters. All vendors should note that it is the intent of the Ontario Ministry of Education to incorporate CSA standards for Canadian bilingual keyboards as soon as they are finalized. All vendors are expected to adopt this standard once it is finalized.

5.2 All keyboards must contain the following additional features:

- 4 cursor control keys in the following recommended pattern:



- a HOME key must be included in the configuration
- a separate numeric keypad
- cursor controls and numeric keypad may be superimposed
- at least 10 definable program function keys, preferably to be placed in a horizontal row immediately above the regular keys
- separate key labeled HELP, DELETE, RESET (or alternatively, a keyboard accessible RESET sequence) and SELECT. The SELECT key must be placed so as not to interfere with the efficient operation of any mouse or trackball and shall permit the simultaneous, single-handed use of the mouse or trackball and the SELECT key.

5.3 The keyboard must generate all 128 ASCII characters

5.4 The keyboard shall be connected in such a way that a program can determine whether a key is depressed and for how long (i.e. software must be provided with both key contact make and break events).

5.5 The keyboard may be separate from the display unit. If the keyboard assembly is separate from the computer's main processor housing, the connection shall be made by a modular plug. If the keyboard and computer are integrated into the same housing, a modular jack must be provided for connection of alternate keyboards.

6 Programming Languages

6.1 Each standard student microcomputer must have available a minimum of the purchasers choice of two of the following three languages:

BASIC,

Pascal (conforming to ANSI standards)

LOGO

languages as identified in Appendix 3 but not necessarily concurrently. The vendor must provide, at least as an option, the third language of the above three.

The vendor must also make available a 'C' compiler with floating point support. Vendors are advised that it is the intent of the ministry to require full ANSI conformance for 'C' compilers, once the standards are finalized. Interim implementations must conform to draft ANSI standards.

6.2 BASIC, Pascal and LOGO must also be available concurrently within any network configuration.

6.3 Documentation of program languages will clearly identify functions or uses which are machine dependent.

7 User Interface

Each machine in the family in either standalone or network mode must provide a consistent user interface which provides for the following:

7.1 A trackball and trackball interface or a mouse and mouse interface, both with software control of relative cursor movement and an associated SELECT key permitting single handed point and select functions.

7.2 Error messages which are clear and unambiguous to assist users in accurately diagnosing and correcting errors.

7.3 Each machine must be able to generate a variety of tones for operator warnings and the generation of music. Each machine must also be capable of producing voice using text to speech conversion. Optionally, vendors must provide a high quality voice reproduction system. Both types of voice reproduction must be fully documented (including file formats) and must be accessible to software developers using the ministry specified software development environment. Each microcomputer must have a volume control, a built in speaker and a speaker disabling headphone jack.

8 Lessonware, Courseware and Other Software

8.1 All microcomputers of the family must be able to deliver all lessonware and courseware written to be consistent with the standards formulated by the ministry.

8.2 A pointing oriented text processor must be available on all machines. Appendix 1 identifies the minimum functionality.

8.3 As part of the evaluation process all machines must be capable of processing a prescribed sample of software written to be consistent with the standards specified by the ministry.

8.4 Programs written for the smallest microcomputer in the family in the languages specified in Appendix 3 must run without modification on all other members of the family.

9 Operating System

9.1 The operating system must support features such as a tree-structured hierarchical file system, pipes, access to devices in the same way as files, redirectable program input and output, restricted file access and file sharing, full and incremental backup and recovery functions, foreground and background execution, startup and shutdown, system administration, etc.

9.2 It must be capable of supporting multiple microcomputers in a local area network, with full access to all files.

9.3 System calls must be provided to dynamically create and destroy processes and to communicate with other processes via synchronous message passing, that is, the system must be fully multitasking.

10 Graphics Standards

10.1 Each machine must use a bit-mapped graphics display for all output and permit a variety of character sizes and styles including accented French, scientific, math, Greek, APL, Inuit, and Bliss symbolic characters. Each machine must support mixed text and graphics in any area of the screen.

10.2 All microcomputers must provide video output.

10.3 All microcomputers must provide at least two display formats

- 640Hx240Vx1
- 320Hx240Vx2 (colour)

Such format changes must not require hardware changes other than the connection of a suitable monitor.

11 Networking Capability

11.1 Each machine must be able to access, as an integral part of the system, a reliable linear or ring local-area network to support a shared-peripheral environment. Support for up to 32 stations must be provided at a data rate of at least 1.0 Mb/s. A download capability for 100K bytes per station to a classroom of

32 microcomputers in less than 1.5 minutes and read and write access must be provided to centrally stored files, language compilers/interpreters and lesson-ware/courseware. The network must be extendable over a cable distance of at least 2000 feet to cover multiple classrooms.

11.2 Initialization of the network must not require operator intervention and the network must automatically reconfigure itself if machines are added to or deleted (e.g. turned on or off) from the network. The network must perform error checking as well as communications management.

11.3 A power and network cabling module must be available to interconnect the components in each configuration in a neat, orderly and safe installation consistent with appropriate electrical standards and the realities of a typical classroom in a school environment (e.g. it must not restrict the movement of students within the classroom).

12 Additional Features

12.1 Each microcomputer must have a minimum of 284K bytes of memory workspace available to the user/application software separate from any system requirements. This is to retain compatibility with existing ministry licensed software. NOTE: This figure may be revised upward.

12.2 All microcomputers must be capable of storing and retrieving configuration data and a serial number or other node identifier without operator intervention.

12.3 All microcomputers must have internal interval timing capability and have access to a real time clock (date and time).

12.4 Each network configuration must provide;

12.4.1 external storage including one or more 5 1/4" floppy disc drives or 3 1/2" floppy disk drives with a formatted capacity of at least 640K bytes. The vendor is to make available full details of the disk storage format,

12.4.2 secondary storage of at least 20 MB using a hard disc accessible across the network to all connected workstations,

12.4.3 connectors, circuity and software for a bit mapped printer and a letter quality printer via a RS-232 serial port or via a Centronics compatible parallel printer port,

12.4.4 connectors, circuitry and software to interface a standard synchronous modem for communication via standard telephone carrier to remote data bases and other computers.

12.5 Expansion capability must be provided to connect additional devices including printers, modems, analog I/0 devices, storage, backup fileservers, etc.

12.6 The design and documentation must facilitate field installation of the entire configuration by staff who have had a one day training program to be provided by the vendor.

13 Reliability and Serviceability

13.1 All cables must be shielded to meet RFI regulations and solidly attached to their respective units. Cables must be detachable and replaceable.

13.2 Each component of the family must have protection against power surges and against static electricity to prevent damage to the equipment.

13.3 Machines must be capable of reliable non-stop operation for at least 10 hours per day by inexperienced operators including young children in any standard classroom environment.

13.4 All component must be delivered with full installation instructions in reusable packaging which is designed to ensure safe delivery by normal transportation methods.

13.5 Documentation, must be comprehensive and written in non-technical language. Complete service documentation with schematics of electronic circuits and parts lists and including documentation of resident machine diagnostics to identify component and network failures must be available for each configuration.

13.6 Each microcomputer and fileserver must provide, a comprehensive self-diagnostic routine with status feedback which will identify as precisely as possible, the failed hardware, software or network component. This diagnostic must be meaningful to a typical user in a school environment. This diagnostic routine should be automatically executed whenever a machine is started up or diagnostic commands are entered at the keyboard.

13.7 All equipment must be designed for field installation by non technical staff.

13.8 A minimum 90 days warranty on parts and labour with service contracts beyond the warranty period must be offered by the vendor. An 8 hour, 5 day a week "hotline" service supported by trained technical staff must be provided by the vendor.

13.9 The vendor shall establish a computer maintenance centre or centres which will be capable of repairing or replacing and shipping any system or component within two business days after receipt.

13.10 The vendor shall provide a minimum two day program of training for school board service personnel.

14 Canadian Content Prequalification

Ontario seeks maximum levels of Canadian content and industrial development benefits from educational microcomputers whose purchase is supported by extraordinary grant assistance to schoolboards. To insure that Canadian content levels and industrial development benefits are realized, vendors seeking approval of their educational microcomputer for extraordinary grant support must meet the following Canadian content prequalification based upon existing Ontario manual of Administration policy regarding Canadian content and industrial development benefits.

14.1 Prequalification

Firms may elect to have their representative systems assessed for Canadian content on the basis of either product content or of corporate Canadian content. Total Canadian content of the educational microcomputers delivered for approval as calculated in a representative classroom configuration or the corporate Canadian content must be a minimum of 60% based on either product content or on corporate content.

14.2 Definitions

14.2.1 Canadian Content

"Product content" method: Everything added in Canada - labour, materials, transportation, duty, taxes and the Canadian supplier's profit - qualifies as Canadian content. Alternatively, Canadian content is the value of the supplier's net selling price minus the declared value of any imported goods or services.

$$\text{Product Canadian Content} = \frac{\text{(total selling price) - imports}}{\text{(total selling price)}} \times 100\%$$

NOTE: This value can be affected by changes in actual selling price over the product's lifetime and must continue to meet this requirement

"Corporate content" method: The total value of all domestic Canadian sales plus the total value of all export sales, less declared value of all imported goods or services (including intracorporate transfers) qualifies as Canadian content.

$$\text{Corporate Canadian Content} = \frac{\text{(total domestic + export sales) - imports *}}{\text{(total domestic + export sales)}} \times 100\%$$

* including intracorporate transfers

14.2.2 Representative Classroom Configuration

A representative classroom configuration is deemed to be one file server plus three workstations or an equivalent to this configuration, and must be capable of demonstrating functionality as described in the Functional Requirements.

14.2.3 Net Selling Price

Net selling price is the price, net of all discounts available or to be made available to purchasers of the representative classroom configuration, payable by an educational facility in Ontario, F.O.B. the supplier.

14.3 Verification

All suppliers seeking approval must be prepared to provide documentary evidence of the Canadian content in components and sub-components of the representative classroom configuration at the time of submission and must maintain acceptable levels.

15 System Qualification

The procedure for the complete evaluation of system proposed as a Stage IA conforming system is as follows:

15.1 A vendor shall submit to the Director, Computers in Education Centre, a written letter of intent to submit a system for evaluation. The vendor will then receive from the ministry a detailed benchmark test document.

15.2 The vendor is to submit a detailed description on paper of the system to be submitted for evaluation, addressing each of the points in this document. The level of detail shall be sufficient to permit ministry staff to readily and efficiently determine whether or not there is reason to believe that the proposed system will fully meet the requirements. Particular note should be made to information on:

- Canadian content estimates for the system as a whole,
- estimated prices,
- licenses for required languages and price estimates,
- support and service arrangements across Ontario.

If, to the ministry's satisfaction, the paper submission appears to bear out the claim that the proposed system will fully meet the ministry's functional requirements, the testing process will continue. Otherwise, the process will be terminated.

15.3 On the basis of a "paper" submission satisfactory to the ministry, the vendor will be asked to submit a representative system for formal testing by a third party testing firm designated by the ministry. The testing firm performs the testing and reports formally to the ministry. The contract for the testing will be negotiated by the ministry. However, the full costs associated with the testing process will be the responsibility of the submitting vendor. Note that these costs include, but are not limited to, transport of test equipment to and from the test site, expenses incurred by the testing firm to set up the system, expenses incurred by the testing firm in travelling to and from the site selected by the vendor for tests involving the full 32 workstation system configuration and any other tests which cannot readily be performed at the testing firm's offices. The vendor is expected to establish a single individual as the official contact for all communications relating to the testing process.

The testing firm will submit to the ministry, copies of the evaluation report. The ministry will provide one copy to the submitting vendor after completion of the testing process. If the completed evaluation supports the vendor's claim that the system under evaluation meets the ministry's functional requirements, the

evaluation process will continue. Otherwise, the evaluation process will be terminated.

15.4 Candidate systems will be required to undergo a field trial prior to the start of final deliberations by the ministry on final acceptance of the system. The period of the field trial is to be 40 school days for initial submissions and 20 school days for resubmissions. Before the field trial, the vendor should approach prospective field trial sites and submit a list of possible sites to the ministry. Among the test sites, the ministry wishes to have representation of urban, rural/Northern areas, English and French speaking institutions and elementary and secondary schools. Three sites (minimum) will be selected by the ministry from the supplied list of prospective sites. At the conclusion of the field trial, each field trial site is required to submit a formal report to the ministry on all aspects of the field trial. All costs incurred by the field trial sites are to be borne by the submitting vendor. Only upon successful completion of the field trial will the evaluation process continue. Otherwise, the evaluation process will be terminated.

Field trials may be conducted in parallel with the benchmark testing, subject to ministry approval. However, should the system be revised as a result of efforts to successfully complete the benchmark process, the ministry may at its sole discretion, require the field trial to be either redone or extended to permit full field evaluation of any such changes for up to the full period for a field trial. All costs incurred in a field trial or any extensions are to be borne by the vendor. The vendor is to negotiate any necessary agreements with field trial sites directly.

15.5 The ministry will designate a system as a Grant Eligible Microcomputer System (G.E.M.S.), provided all requirements for qualification of the candidate system have been met, the benchmark testing confirms full technical conformance and the field trials unanimously provide unqualified support for granting the G.E.M.S. designation. Only upon granting G.E.M.S. designation as described above, will the ministry announce the participation of a vendor in the evaluation process and the announcement will indicate only the granting of the designation.

15.6 The submitting vendor will be required to provide a unique product identification to the G.E.M.S. system to clearly differentiate it from other systems which may be offered by the vendor. Should the vendor wish to revise the system or any of its components after G.E.M.S. designation has been supplied by the ministry, prior written notification must be supplied to the ministry, outlining full details of the proposed revision(s). On a case by case basis, and at the sole discretion of the ministry, indication will be provided to the vendor as to whether or not benchmark testing and/or field trial will be required to obtain G.E.M.S. designation for the system or whether alternate procedures will be acceptable. The ministry may also require a revision in the unique product identification.

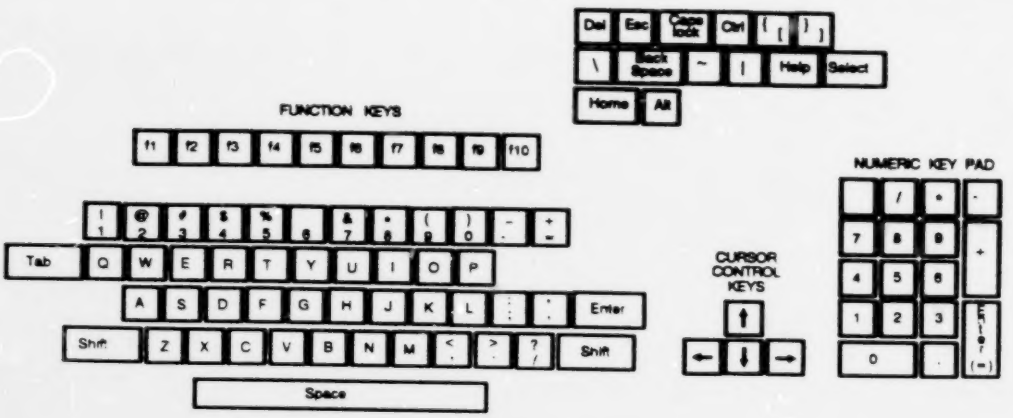
APPENDIX 1 Text Processing Functionality

The Text Processing Applications Software must have the following minimum functionality

- Capable of a minimum of 5000 character internal buffer storage
- 80 column capability
- Full cursor control using a mouse or trackball with a default mode of 4 separate designated keys
- Automatic and manual line ending
- Insert and delete functions
- Full tab and margin setting
- Block movement and deletion of text
- Removable storage of text in machine managed files
- Printer controls
- Page retrieval within text file
- Alignment of text function
- User definable function keys
- Underline capability
- English and French (with accents) upper and lower case
- Centre function
- Facility for teacher or student to create a subset of functions which are appropriate to the student.

APPENDIX 2 Keyboard

System vendors are hereby notified that it is the intent of the ministry to adopt CSA standards for keyboards for bilingual use in Canada, when such standards are finalized.



Recommended Keyboard Layout...Stage 1A

The keyboard diagram is the recommended interim layout and in addition to the indicated keys, interim keyboards must be capable of generating all accented French characters in upper and lower case using no more than two keystrokes for lower case or three keystrokes for upper case. All vendors are expected to adopt the CSA standard for keyboard layout as the standard layout on all systems.

APPENDIX 3 Programming Languages

BASIC

Pascal (conforming to ANSI standards)

And

Logo:

Minimum Commands which must be supported:

Procedures

Clearscreen, Forward, Home, Left, Back, Text, Right, Colour, position (x and y) show or hide graphics, repeat

Variables:

name, name object, object name, word, string

Operators:

Integer, quotient, random, remainder sum ab, a+b, a-b, axb, a/b, a(b, a)b, and, or, not

Conditionals:

Pause, repeat, list, stop other

Commands:

Print, Show, clear text, save, load, catalogue

Or Preferably

An implementation of Logo including all the functions identified in:

Apple Logo

Reference Manual

by

Lawrence J. Davidson

Logo Computers Systems, Inc. 1982